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Pink Hibiscus Mealybug

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Background

The pink hibiscus mealybug (PHM), *Maconellicoccus hirsutus* (Green), is a serious economic threat to agriculture, forestry, and the nursery industry. This pest attacks many plants, trees, and shrubs. It infests hibiscus, citrus, coffee, sugar cane, annonas, plums, guava, mango, okra, sorrel, teak, mora, pigeon pea, peanut, grape, maize, asparagus, chrysanthemum, beans, cotton, soybean, and cocoa, just to name a few of its hosts. For a comprehensive list of host plants, see **Appendix A**.

This pest occurs in most tropical areas of the world including Asia, the Middle East, Africa, Australia, and Oceania. PHM arrived in Egypt from India in 1912 and in Hawaii in 1984. Finally, it appeared in Grenada, Trinidad, and St. Kitts in the early 1990's. It is now a very serious pest in the Caribbean, found on at least 16 islands including the U.S. Virgin Islands, where it attacks many economically important hosts and disrupts Caribbean agricultural trade and commerce.

Biological Control Project Against PHM

The Animal and Plant Health Inspection Service (APHIS) of the U.S. Department of Agriculture (USDA) is charged with protecting American agriculture from exotic plant pests like PHM. APHIS considers PHM a pest of extremely serious quarantine importance that has the potential to expand its geographical distribution to North, Central, and South America. Two units of APHIS, Plant Protection and Quarantine (PPQ), and International Services (IS), are cooperating in a biological control project aimed at controlling PHM in the Caribbean. This project will serve as a model to start a biological control program in the mainland U.S. when PHM arrives. The purpose of this manual is to guide USDA personnel and cooperators (see **page 1-12**) in setting up and maintaining these biological control programs.

Description of the Insect

The adult PHM is about 2-3 mm long. Females are oval shaped, wingless, and covered by a mass of white mealy wax. Males have one pair of wings, two long waxy tails, and can fly. For a more detailed description (Hall, 1921) modified for field use, refer to the subsection Distinguishing Field Characters on **page 2-9**. See also the insert following page 2.8 for color photographs of PHM.

Systematic Position

The taxonomic classification of PHM is summarized as follows:

Phylum: Arthropoda
Class: Insecta
Order: Homoptera
Family: Pseudococcidae
Genus: *Maconellicoccus*
Species: *Maconellicoccus hirsutus* (Green)

Williams (1996) has recently reviewed *M. hirsutus* taxonomically. Ezzat (1958) separates the genus *Maconellicoccus* from *Paracoccus*, the closest known relatives, by the following features in the adult female:

- Pseudo articulation in the 9th (terminal) antennal joint
- Anterior leg with unequal tarsal digitules
- Small oral collar tubular ducts present on both the dorsal and ventral sides of the body

PHM is one of apparently nine species in *Maconellicoccus*. The genus is probably Far Eastern, possibly of tropical Australian origin, as five of nine species are found there. Of those five species, three have become adapted to a more moderate subtropical climate, especially *M. tasmaniae*, found only in temperate Tasmania. In Africa, there are only two species, including the PHM, which may have spread there recently. The other species, *M. ugandae*, has a strictly tropical African distribution (Williams, 1985 and 1986). *M. australiensis* (Green & Lidgett), *M. lanigerus* (Fuller), *M. leptospermi* Williams, *M. hirsutus* (Green) and *M. tasmaniae* Williams all occur in Australia; *M. multipori* (Takahashi) in Malaysia and *M. ramchensis* sp. n. *M. pasaniae* in Nepal (Williams, 1996).

PHM is the only species with a worldwide distribution. It probably spread to Africa along tropical routes from the oriental region. Some of this spread is recent: Egypt, 1908 (Williams, 1986); Hawaii, 1984 (NPAG, 1984); and the West Indies in 1994 (Pollard, 1995).

Biology / Ecology

PHM is a small, soft-bodied insect with a nonflying female and a flying male. The intermediate life stages, illustrated in **Figure 1-1 on page 1-5**, are eggs and three (female) or four (male) nymphal instars. The female lays its eggs in ovisacs, which it deposits on the host, sometimes in great numbers and visible as a whitish covering over the terminal parts or even main areas of the host. The female, the nymphal stages, and the male, if present, are very visible on the host as well. All stages are reddish to pink in color, but covered in white mealy wax, with the body color showing through. For that reason the insect is often called the pink hibiscus mealybug.

Many researchers have studied the life cycle of PHM. **Table 1-1** (from Mani, 1989) summarizes their findings.

TABLE 1-1: Summary of PHM Biological Data (Mani, 1989)

Particulars	Misra 191)	Hall (1921)	Dutt et al. (1951)	Singh and Ghosh (1970)	Ghose (1970)	Mani (1986)	Reddy and Lakshmi Narayana (1986)
Egg length (mm)	0.36-0.39	-	0.29-0.32	-	0.357-0.398	0.34-0.38	-
Egg width (mm)	0.15-0.21	-	0.17	-	0.178-0.206	0.17-0.20	-
Incubation (days)	5-8	6-9	7	6-7	3-8	4-7	3-4
Nymph (days)	-	-	-	22	10-19	19-22	20-22
Egg to adult (days)	24-29	35	-	-	23-29	24-27	30
Adult length (mm)	2.52	-	3	-	-	2.65-2.80	-
Preoviposition (days)	-	-	-	3-5	0.5-6	4-5	-
Oviposition (days)	-	-	5-8	4-5	-	6-8	-
Fecundity (no. eggs /female)	232	150-300	194	-	84-654	386-540	500

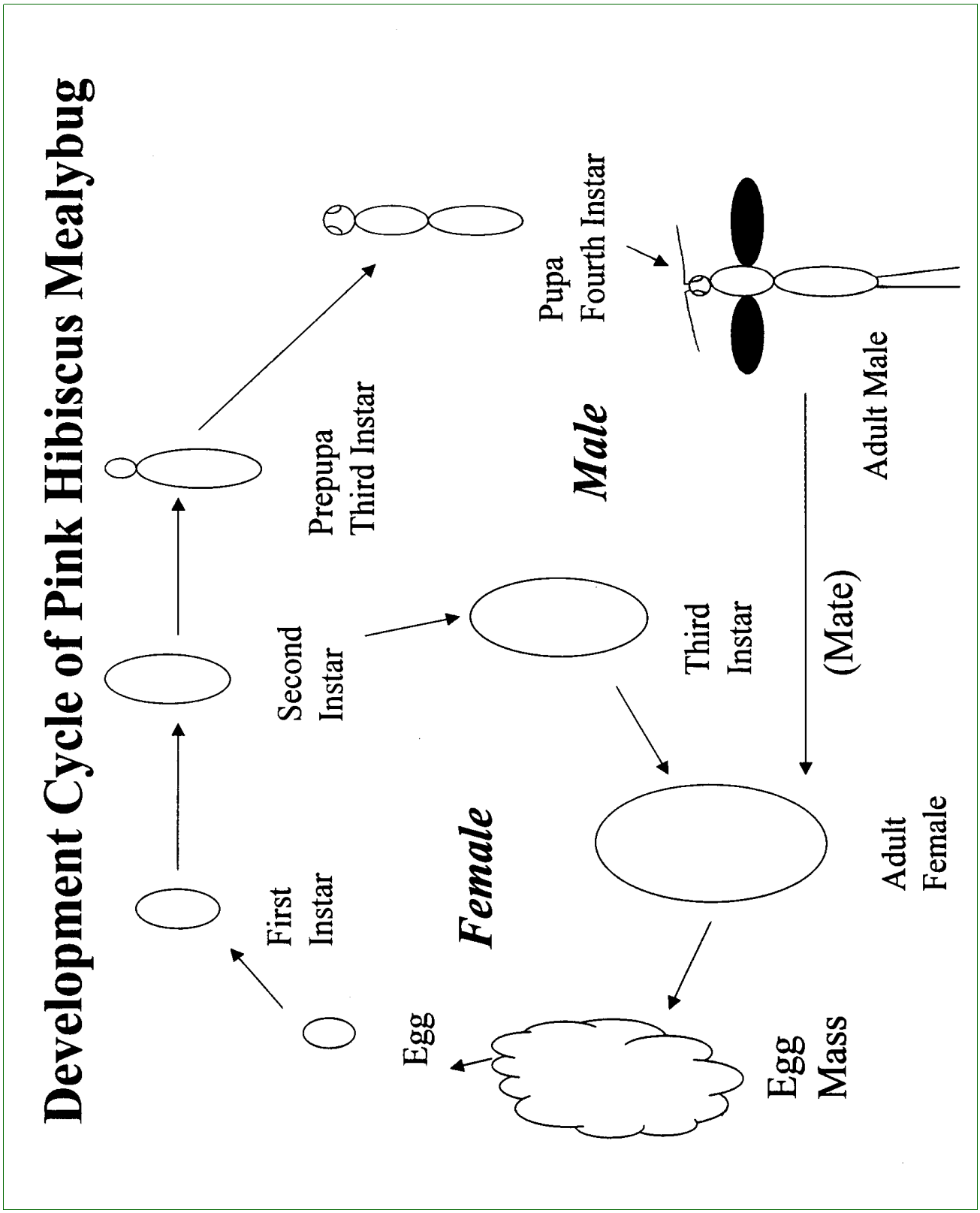

FIGURE 1-1: Development Cycle of Pink Hibiscus Mealybug (PHM)

Natural Protection

The natural wax coating covering the various stages of the PHM provides some protection from pesticides. This is especially true of the egg stage, which is protected by a white, waxy ovisac. The ovisac is almost impossible to penetrate with many pesticides (McKenzie, 1967).

The PHM's ability to hide in cracks and crevices is probably the most important means by which it protects itself. Once hidden, reaching it by both natural enemies and humans is difficult (McKenzie, 1967).

Some sugar-loving ants will protect the PHM from parasites and predators. The ant, *Monomorium indicum*, was observed in India attending the nymphs and maturing females for their honeydew. They do not attend to male nymphs in the last nymphal stage nor to gravid females that have begun laying eggs because they no longer produce honeydew (Misra, 1920).

Reproduction and Development

Mani (1989) reports that males are very common, but parthenogenetic reproduction has been reported in the literature. Overall, researchers assume reproduction is restricted to the sexual form with the sex ratio approximately 1:1. From 84 to 654 mealybug eggs are laid in a loose cottony terminal white ovisac. They are in close contact with each other within the ovisac. Eggs turn pink before they hatch, 3–8 days after being laid.

Newly hatched mealybugs (crawlers or first instar nymphs) are mobile. They settle on the host and start their development, which lasts 10 to 22 days. Although they prefer the apical and tender regions of the host, under field conditions the older plant parts, including stems, leaves, petioles, roots, tubers, and even the pods, may harbor large populations of the crawlers (Ghose, 1972). Male and female nymphs are distinguishable by the end of the second instar. The male has four instars of 6.60 ± 0.50 days, 6.51 ± 0.51 days, one day, and 5.59 ± 0.69 days each, while the females have three instars of 6.71 ± 0.47 days, 6.55 ± 0.52 days and 7.9 ± 0.79 days. At the end of the second instar, males produce cottony cocoons (puparia) (Mani 1989).

Females are wingless and dark pink. They migrate to the lower parts of the host as the affected apical portions wither away (Ghose, 1972). Preoviposition is from 0.5 to 6 days, followed by an ovipositional period of 4 to 8 days. Oviposition normally occurs in the terminal areas of the host, but when the weather gets cooler, the females search for shelter to oviposit. These include crevices in the bark (of a tree) or other shelter on the host (Hall, 1926). Activity on roots has been reported in a few cases, but the circumstances are not clear (Rao & Srinivasan, 1987; Hall, 1921; Hosny, 1939).

There are about 10 generations a year in the subtropics. If there is a winter season, PHM will hibernate or remain quiescent in any or all of its stages until food plants are again available. The pest may overwinter in protected parts of the host such as the capsules of kenaf or sorrel, cracks and crevices of bark, inside fruit bunches or in the soil. Maximum populations are reached in late summer and early fall.

Although PHM by itself is not greatly mobile, the crawlers, ovisacs, and males may migrate by means of air currents. The females, crawlers, and nymphs are mobile and can walk from host to host in the infested area. Males are probably attracted to the female over several hundred meters at best (Misra, 1920) and seem to stay within the infested area as well.

Damage

The PHM's toxic saliva and direct feeding may cause various symptoms in the host plants. These symptoms are generally severe malformation of shoots and leaves. Leaves become twisted and crinkled. Growth becomes stunted and shoot tips have a bushy appearance. Infested flowers dry and drop and fruits are not produced. Infested fruits are small and abnormally shaped, and may drop early, thus reducing production and marketability (Francis-Ellis, 1995).

Specific hosts may exhibit symptoms as in the following examples:

- In **hibiscus**, PHM usually infests young twigs (**Figure 1-2**), causing gall-like deformations of the terminal growth. Note mealybugs and egg masses. The infestation is characterized by internode shortening or "Bunchy Top" (**Figure 1-3**), deformed leaves and thickened twigs (Veni, et al, 1973; Beardsley, 1985). Note stunted, distorted leaves. Heavy infestations can result in leaf defoliation, stunted leaves, and death of the plant (**Figure 1-4**).

FIGURE 1-2: Infected Hibiscus Twig

FIGURE 1-3: "Bunchy Top" on Citrus

FIGURE 1-4: Hibiscus Defoliated by PHM

- In **mulberry**, the shoots of the affected plant first turn coppery-green, then pale-yellow and finally become so hard, compact, and brittle that they cannot be opened without breaking. The lower lateral leaves become seared and fall off prematurely. In severe attacks, nothing but the bare stems of plants remain in the field (Misra, 1920).
- In **roselle**, floral branching is suppressed, the tips are gradually withered and the floral buds are reduced and distorted. This results in a drastic reduction in seed loss—about 21–43 percent of normal production—due to a reduction in the number and quality of the pods (Ghose, 1971).
- In **cotton**, the growing parts are attacked resulting in bunchy-type symptoms. Attacked plants remain stunted and produce fewer bolls of a smaller size. Boll opening is adversely affected and yield reduction ranges from 58–73 percent (Dhawan, 1980). PHM is recorded, but rare on the roots of cotton plants under severely attacked trees (Hosny, 1939).
- In **grapevine**, PHM feeds on the developing sprouts after pruning and stunts their growth. The growing shoots and the leaves are malformed due to sticky honeydew produced by the pest, predisposing them to moldy growth and bunching. Heavily infested bunches shrivel and drop. Damage can be as much as 90 percent occasionally (Babu & Azam, 1987).
- In **peanuts**, PHM feeds on the underground parts of the roots, pods, and pegs of the plant. This results in stunted growth and poorly developed pegs and pods (Rao & Srinivasan, 1987).
- In **trees**, PHM feeds on tender young growth, although this can change to older growth if the infestation is high. This results in malformed leaves and shoots, which become gnarled and form compact heads. As a result, dieback of young shoots and limbs may occur resulting in eventual death of the tree. Some trees may be very obviously infected and covered with PHM, emitting a distinctive odor (Hall, 1921; ANON., 1995; Hall, 1926).
- In **other hosts**, symptoms may vary, but dieback of attacked areas often results. Death of the host, including large trees, is very common (**Figure 1-5**).

FIGURE 1-5: Dead Saman tree

Economic Losses

In many countries, this pest is chiefly restricted to *Hibiscus* and is not of concern, possibly because it is kept in check by natural enemies. In some areas of India and Egypt, however, PHM is a serious pest of some important crops, especially where no natural controls are present. In these countries it does seem to have many hosts, but of these hosts few are heavily attacked. When this mealybug turned up in Hawaii in 1984, it did not become a problem because natural enemies were apparently fortuitously introduced with it. In the Caribbean islands where natural enemies were absent, PHM became a very serious problem, attacking many plants and disrupting the agricultural sector to a major extent, and causing significant financial losses. Grenada reported economic losses of $3.5 to $10 million for the 1996/97 season, and Trinidad and Tobago estimate potential losses exceeding $125 million/year if infestations continue to escalate.

Geographic Distribution

PHM seems native to southern Asia (Williams, 1996) as based on its distribution and that of members of the genus *Maconellicoccus*. PHM is the only species with a virtually worldwide distribution in tropical areas of the world from Australia through Southeast Asia, the Middle East and central Africa. It has recently spread to Guam, Hawaii, and the Caribbean. Since the discovery of PHM in Grenada in November 1994, it has been found in Trinidad (August 1995), and St. Kitts & Nevis (November 1995). For maps showing world and Caribbean distribution, and a list of infested islands and countries in the Caribbean, see **Introduction.**

Host Range

PHM attacks more than 200 genera of plants in 70 different families. Many of these are economically important representatives of the following groups:

- Forest trees
- Fruit trees
- Ornamentals
- Root crops
- Vegetables

For an extensive list of hosts recorded with damaging populations of PHM, see **Appendix A.**

Any local survey needs to take into account both the host list given in **Appendix A,** and local plant species that may be hosts. PHM changes host preferences by locality, perhaps as a reflection of changes in habitat, environment, and interactions with the local flora/fauna/predator/parasite complex. Surveyors should design a local host list based on actual local finds.

Biological Control

Biological control, when considered from the ecological viewpoint as a phase of natural control, can be defined as "the action of parasites, predators, or pathogens in maintaining another organism's population density at a lower average than would occur in their absence" (DeBach, 1964). Biological control of PHM is the best long-term solution, since pesticides are not effective. Natural enemies can control the pest in a way that is safe to humans and the environment.

Types of Natural Enemies

Overall, natural enemies are classified as one of the following types based on how they control the target pest:

- Parasite: Completes its growth and development on or in a single host, killing that host in the process
- Predator: Finds and kills a number of prey to complete growth and development
- Pathogen: Controls the pest by causing a fatal disease that spreads to other host individuals (includes bacteria, fungi, and viruses)

Many exotic natural enemies have been reported in the literature and are under consideration for importation and release to regulate PHM in the Caribbean (see **Appendix C**).

These four natural enemies have been released in St. Kitts and Nevis:

Parasites (tiny wasps)

- *Anagyrus kamali* (Hymenoptera: Encyrtidae)
- *Gyranusoidea indica* (Hymenoptera: Encyrtidae)

Predators (lady beetles)

- *Cryptolaemus montrouzieri* (Coleoptera: Coccinellidae)
- *Scymnus coccivora* (Coleoptera: Coccinellidae)

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Pink Hibiscus Mealybug

Introduction

Who's Involved

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Cooperators

PPQ and IS are directing the biological control project with the assistance of many cooperators, including the following:

- Belize Ministry of Agriculture and Fisheries
- California Department of Food and Agriculture
- Egypt Ministry of Agriculture
- Florida Department of Agriculture
- Grenada Ministry of Agriculture
- International Institute for Biological Control (IIBC), CABI[1]
- Puerto Rico Ministry of Agriculture
- St. Kitts Ministry of Agriculture
- Trinidad and Tobago Ministry of Agriculture
- University of Florida
- University of Hawaii
- University of the Virgin Islands
- USDA, Agricultural Research Service (ARS)
- U.S. Virgin Islands Ministry of Agriculture

The St. Kitts Ministry of Agriculture has been extremely cooperative in providing assistance in the development of a biological control technology. Ministry of Agriculture personnel have helped administratively and provided necessary transportation, staff, facilities, and host material as needed during the first year of the program. For a list of key cooperators in the United States, the Caribbean, and elsewhere, see **Appendix D**.

1 Center for Agriculture and Bioscience International.

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Pink Hibiscus Mealybug

Introduction

How to Use This Manual

Use the PHM Manual as an on-the-job reference for general information and for detailed information on these topics:

- Surveying for PHM
- Developing a biological control program
- Setting up an insectary
- Releasing natural enemies
- Evaluating the establishment and impact of natural enemies

Each tabbed section is independent, containing step-by-step procedures.

Each section has an introduction that contains general information relating to the section's main content.

Use the appendixes as they relate to the other sections of the manual. In some places, the manual will refer you to an appendix; in other places you may need to go directly to an Appendix to get the necessary information.

If the table of contents is not specific enough, use the index to find a topic and its page number.